

Chapter Ind 6

TRENCH, EXCAVATION AND TUNNEL
CONSTRUCTION

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History: Chapter Ind 6 as it existed on December 31, 1962 was repealed and a new chapter Ind 6 created effective January 1, 1963.

Part I

GENERAL

Ind 6.01 Scope. These rules shall apply to all tunnels, caissons, accessory shafts and trenches while under construction with the exception of tunnel construction in connection with mines. The following types of construction are understood to be included: lateral trenches (house connections), water taps and connections, sanitary and storm sewers, welded pipe lines, water mains, basements, footings, dry well excavations, manholes, shafts, storage tunnels, and all other excavations.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.02 Definitions. For the purpose of these rules the following items are defined. (1) TUNNEL is a subterranean passage or chamber constructed without the removal of a superincumbent material.

(2) SHAFT is an excavation made from the surface of the ground, the longer axis of which is steeper than 45 degrees. Widening of a trench to accommodate a manhole shall be considered a trench.

(3) TRENCH means a longitudinal excavation made from the surface of the ground.

(4) **CONSTRUCTOR** means a person, firm or body corporate in immediate control of the construction of any excavation and subsequent construction and as such responsible for the condition and management thereof.

(5) **SUPERINTENDENT** means a person resident on the work having general supervision and responsibility.

(6) **FOREMAN** means a person in charge of a subdivision of the work or of the entire work at any one time and under the instructions of the superintendent or constructor.

(7) **WORKS** or **WORKINGS** means any or all parts of any project excavated or being excavated as well as shafts and approaches, power houses, lumber yards, storage yards and structures of all kinds, which are in the immediate vicinity of and used in connection with the excavation or the immediate disposal of excavated material or in connection with any phase of the construction project.

(8) **PERSON** means a firm or body corporate as well as natural persons.

(9) **UNDERGROUND** means within the limits of any shaft or tunnel.

(10) **EMPLOYES** or **PERSONS EMPLOYED** means all persons receiving compensation from the constructor or others for labor or services performed on the works.

(11) **APPROVED** (unless otherwise specified) means approval by the industrial commission.

(12) **PRESSURE** means gauge pressure in pounds per square inch.

(13) **OPEN AIR** shall be defined as well ventilated under normal atmospheric pressure.

(14) **TIGHT SHEATHING** means planks shall be abutting.

(15) **SAFETY SCREEN** is an air-tight diaphragm placed across the upper part of the tunnel between the shield and the emergency air lock. The function of the safety screen is to prevent flooding of the upper part of the tunnel between the screen and the lock by forming in effect a diving bell in which the air is retained, preventing the water from rising above a certain level. The lower edge of the screen should be placed at a horizontal plane below the entrance to the emergency lock.

(16) **TIMBER SIZES**. Timber sizes required in this code are stated as nominal sizes.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.03 Inspections. (1) All excavations, timbering and equipment shall be inspected daily. All dangerous conditions or defects shall be made safe. The constructor or his representative shall be responsible for these inspections and the safety of all workmen at all times.

(2) Frequent inspections of rock excavations, including tunnels, shafts and trenches shall be made by the constructor or his representative and loose rock which may fall shall be removed.

(3) After a blast is fired these requirements for inspection and removal of loose rock shall be complied with before proceeding with the work.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

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Ind 6.04 Care of the injured. (1) It shall be the duty of employers to keep at such place or places as shall be convenient and accessible to employes in shafts or tunnels a wire basket stretcher and a woolen blanket for use in carrying any person who may be injured.

(2) An approved supply of first aid material shall be kept and maintained at all times in a dust and moisture-proof box.

(3) Information regarding emergency handling of the injured shall be posted whenever possible.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.05 General safety. (1) **PROJECTING NAILS.** All spikes and nails with points projecting shall be bent down or removed from lumber lying in or about working places.

(2) **SAFETY BELTS.** Approved, tested and regularly inspected safety belts or harnesses and ample lengths of $\frac{3}{4}$ inch diameter rope shall be provided for emergency use.

Note: Lists of approved safety belts can be secured from the industrial commission.

(3) **PROTECTIVE HATS.** All workers on tunnel, shaft, trench, and caisson projects shall wear protective hats or caps of approved design and manufacture.

(4) **PROTECTIVE FOOTWEAR.** It is recommended that approved hard toed boots or shoes be worn by all underground or surface workers exposed to toe injury hazards.

(5) **SOLITARY EMPLOYMENT.** No man shall be allowed to work in any trench, except one which is properly side sloped, shaft, tunnel, caisson, or appurtenance over $4\frac{1}{2}$ feet in depth without another man being present at the surface.

Note: Any casual entrance into an excavation such as retrieving fallen objects shall not be construed as work under this section.

(6) **BLASTING.** All blasting procedure shall comply with the provisions of the Wis. Adm. Code, chapter Ind 5, Explosives.

(7) **HOUSEKEEPING.** All change houses, passageways, ladders and working areas shall be kept clean and unobstructed to provide reasonably secure footing according to the needs of the operation. Materials for distribution and use shall be piled and stacked as safe as circumstances will permit. Supplies, materials and tools shall not be stored in change houses.

(8) **WORKMAN.** Every reasonable precaution shall be taken to insure the safety of the workman in all cases whether or not provided for in these rules.

Note: Attention is directed to the provision of Wis. Stats. 66.047, relative to protecting underground facilities in streets, highways, etc., and informing the utility concerned.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Part II

TRENCHES AND EXCAVATIONS

Ind 6.06 Timbering requirements and procedures for trenches and other excavations. (1) **BRACE OR SLOPE.** All areas in trenches in which men are permitted to work shall be adequately and securely timbered or sloped as follows.

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(a) *Depth. Exception.* Trenches cut in hard solid soil need not be braced or sloped if less than 4½ feet in depth. Trenches cut in loose or sandy soil need not be braced or sloped if less than 3 feet in depth.

(b) *Rock. Exception.* Trenches need not be timbered if excavated in solid rock and if there have been no previous known excavations within the minimum lateral distance of the depth of the trench being excavated. The total depth of the trench must be in rock or any overburden must be sloped or braced.

(c) *Sloping. Exception.* Trenches need not be timbered if the sides are cut down to the angle of repose. The angle of repose shall not be considered greater than one to one-half (measuring one foot of rise to each ½ foot horizontal) for dry or moist soils and not more than one to one for wet or heavy soils.

(2) **PARTIAL SLOPE AND BENCHES.** When the sloping of trench walls to the angle of repose does not extend to the bottom of the trench, level benches 2 feet wide shall be provided between the toe of the slope and the top edge of the vertical walls. The vertical part of a partially sloped trench shall be braced according to its vertical depth below the bench. If benches are not provided as in case of the necessary trimming back of loose material at the surface, the trench shall be braced according to its total depth. Upright braces in all partially sloped excavations shall extend not less than 2 feet above the vertical portion of the trench. Toeboards with a total of 12 inches in height shall be placed behind all uprights to prevent material from falling into the vertical portion. The spoil pile adjacent to a partially sloped trench shall be kept at least 2 feet from the top of the slope at the surface.

(3) **UNDERCUTTING.** All trenches shall be cut with vertical walls unless side sloped to required minimums. Undercutting or trenches sloped to less than required minimums shall not be permitted.

(4) **BASEMENT EXCAVATION.** All basement excavations shall comply with the provisions of the Wis. Adm. Code, chapter Ind 35, Safety in Construction.

(5) **TIMBERING TABLES.** Timbers shall be installed according to tables of trench timbering requirements contained in this code.

(6) **GOOD INSTALLATIONS.** In using tables 1, 2, 3, 4 and 5, the maximum distance from the top of the trench to the top cross brace shall be 2 feet. The maximum distance from the bottom of the trench to the bottom cross brace shall be 3 feet. All sheathing shall extend from the ground surface to at least within 6 inches of the bottom of the trench. If any cross braces are removed to install pipe or other conduits, men shall not be allowed to work in these unprotected areas except to replace the cross braces.

(7) **GOOD TIMBER.** All timbers used for supporting sides of trenches shall be of good quality, reasonably straight grained and free from weakening knots and other defects.

(8) **DRIVING SHEATHING.** When sheathing is driven by power equipment, drivers especially designed for the purpose shall be used.

(9) **PLANS FOR APPROVAL.** For trenches and other excavations exceeding 40 feet in depth or 12 feet in width, plans for timbering shall be submitted to the industrial commission for approval.

(10) **EQUIVALENCY APPROVAL.** Other methods of supporting the walls of an excavation may be approved if designed and constructed to afford equivalent protection.

(11) **BARRICADE.** A temporary guard railing or other effective guard or barricade shall be provided at or near the sides of excavations and shall be kept in place at all times, except at such times when safeguards will interfere with excavation or other work except in places not frequented by the public.

(12) **NIGHT LIGHTS.** All trenches exposed at night shall have lighted red lanterns, torches, or flashers placed along the exposed side or sides.

(13) **LADDERS.** A substantial ladder shall be provided for access to all trenches more than 6 feet in depth. The ladder shall project out of the trench at least 36 inches.

(14) **BRACE REMOVAL.** While removing trench bracing, workers shall be required to work only in that portion of the trench where bracing is still in place.

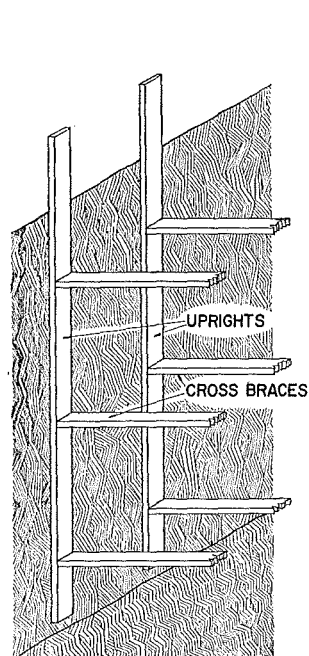


Fig. 1.—Trench Timbering—
Solid Soil

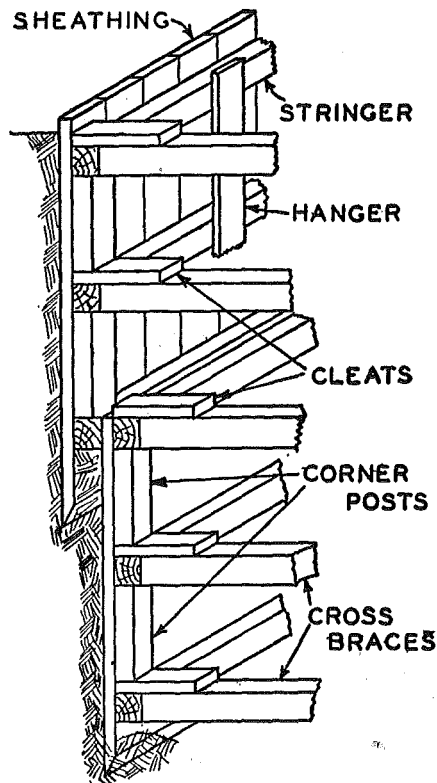


Fig. 2.—Trench Timbering—
Loose Soil

TABLE 1—TRENCH TIMBERING REQUIREMENTS
For trenches not exceeding 10 feet in depth and width not exceeding 42 inches

	Kind of Soil	Uprights	Cross Braces	Stringers**
Where no parallel excavations exist or have existed within 10 ft.	Hard, solid soil	2x6 inch planks spaced 6 ft. c—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	None
Previous excavations 5–10 ft. from trench	Hard, solid soil	2x6 inch planks spaced 4 ft. c—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	None
Previous excavations less than 5 ft. from trench	Hard, solid soil	2x6 inch planks spaced 3 ft. c—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	None
Irrespective of any previous excavation	Soil that splits easily	2x6 inch planks spaced 3 ft. c—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	1x6 inch boards placed back of uprights near top of trench
Irrespective of any previous excavation	Gravelly or filled in ground	2x6 inch planks spaced 2 ft. c—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	1x6 inch boards placed back of uprights near top of trench
Irrespective of any previous excavation	Sand or very wet soil	2 inch tight sheathing	3x6 inch timbers or equivalent horizontally spaced not exceeding 6 feet	3x6 inch timbers or equivalent—2 for depths 7 ft.; 3 for depths 7 ft. to 10 ft.

Note: c—c means center to center.

* In lieu of these cross braces for each upright, 3x6 inch stringers may be used with substantial cross braces spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

**Stringers shall be properly supported by posts or cleats.

TABLE 2—TRENCH TIMBERING REQUIREMENTS

For trenches over 10 feet and not exceeding 15 feet in depth and width not exceeding 42 inches

	Kind of Soil	Uprights	Cross Braces	Stringers**
Where no parallel excavations exist or have existed within 15 ft.	Hard, solid soil	2x6 inch planks spaced 4 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	None
Previous excavations 10 to 15 ft. from trench	Hard, solid soil	2x6 inch planks spaced 3 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 feet; 4 for depths 13 ft. to 15 ft.	None
Previous excavations less than 10 ft. from trench	Hard, solid soil	2x6 inch planks spaced 2 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	None
Irrespective of any previous excavations	Soil that splits easily	2x6 inch planks spaced 2 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	1x6 inch boards placed back of uprights near top of trench
Irrespective of any previous excavations	Sand, gravel filled in ground or very wet soil	2 inch tight sheathing	3x6 inch timbers or equivalent, spaced 6 ft. c—c	6x6 inch timbers or equivalent—3 for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.

Note: c—c means center to center.

* In lieu of these cross braces for each upright, 3x6 inch stringers may be used with substantial cross braces spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

** Stringers shall be properly supported by posts or cleats.

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TABLE 3—TRENCH TIMBERING REQUIREMENTS
For trenches over 15 feet in depth and width not exceeding 42 inches

	Kind of Soil	Uprights	Cross Braces	Stringers**
Irrespective of any previous excavations	Hard, solid soil	2"x6" 2' c—c 15'-17' 2"x6" 1' c—c 17'-20' 2"x6" tight over 20'	Use Table No. 4	Use Table No. 4
	Soil that splits easily, sand, gravel, filled in ground, or very wet soil	2" tight sheathing		

Note: c—c means center to center.

** Stringers shall be properly supported by posts or cleats.

TABLE 4—TRENCH TIMBERING REQUIREMENTS

For trenches over 42 inches in width up to and including 12 feet in width

Depth of Trench	Uprights	Cross Braces	Stringers
Over 4½ ft. to 10 ft. incl.	(*)	4x6 inch timbers spaced horizontally 7 ft. face to face	4x6 inch timbers spaced 4 ft. c—c
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 4 ft. c—c
Over 10 ft. to 20 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 4 ft. c—c
		8x8 inch timbers spaced horizontally 11 ft. face to face	8x8 inch timbers spaced 4 ft. c—c
Over 20 ft. to 30 ft. incl.	(*)	6x8 inch timbers spaced horizontally 7 ft. face to face	6x8 inch timbers spaced 3 ft. c—c
		8x8 inch timbers spaced horizontally 11 ft. face to face	8x8 inch timbers spaced 3 ft. c—c
Over 30 ft. to 40 ft. incl.	(*)	8x8 inch timbers spaced horizontally 7 ft. face to face	8x8 inch timbers spaced 3 ft. c—c
		12x12 inch timbers spaced horizontally 11 ft. face to face	12x12 inch timbers spaced 3 ft. c—c

(*) Uprights shall consist of 2 inch planks and spaced to comply with specifications for trenches less than 42 inches in width.

TABLE 5—TRENCH TIMBERING REQUIREMENTS

For trenches 4½ to 15 feet in depth, 3½ to 12 feet in width, and cut in hard soil*

Depth (ft.)	Width (ft.)	Uprights	Cross Braces
4½- 8	3½-12	2x6 inch planks spaced 4 ft. c—c	2—3x6 inch struts spaced 4 ft. c—c
8 -12	3½-12	2x6 inch planks spaced 4 ft. c—c	3—4x6 inch struts spaced 4 ft. c—c
12 -15	3½-12	2x6 inch planks spaced 4 ft. c—c	4—4x6 inch struts spaced 4 ft. c—c

*In case unstable soil is encountered, bracing shall immediately revert back to that outlined in Table 4.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Part III

SHAFTS AND TUNNELS

Ind 6.07 Flammable material and fire protection. (1) Every reasonable precaution shall be taken against fire in and about tunnels and adequate fire protection shall be provided as hereafter required.

(2) Gasoline, naphtha, distillate, fuel oils and other dangerous flammable materials shall be stored in a building kept solely for such storage and the location of which is at least 100 feet away from any shaft, tunnel or approaches, or any building directly connected with the tunnel opening and at least 300 feet distant from any explosive magazine.

(3) If oil or gasoline storage places are so located that leakage would permit oil or gasoline to flow in the direction of the shaft means to prevent such flows shall be provided.

(4) Not more than a one day supply of lubricating oil or grease shall be kept in underground workings.

(5) The storage of gasoline, naphtha and other distillates in underground workings is prohibited.

(6) Waste or decayed timbers shall not be stored in the tunnel, but shall be promptly removed therefrom. Empty boxes, wooden chips, paper and combustible rubbish of all kinds shall not be allowed to accumulate underground.

(7) When welding or flame cutting is being done in compressed air, a watchman with a fire hose or approved extinguisher shall stand by until such operation is completed. Acetylene shall not be used in compressed air at acetylene pressures exceeding 15 pounds per square inch gauge, or 30 pounds per square inch absolute.

(8) Combustible materials in an amount greater than a one day normal requirement shall not be stored or kept within 20 feet of tunnel shafts.

(9) Any container used for pouring gasoline shall be provided with a closed top, flexible spout and a safety screen and no open light shall be permitted within a 10 foot radius of the gasoline tank, while filling operations are in progress.

(10) Fire hose connections with at least 50 feet of hose attached shall be provided at the shaft opening if water pressure is available.

(11) Fire extinguishers of 2½ gallon capacity protected against freezing shall be installed in all power plants and at shaft openings.

(12) Head frames built of combustible material shall be of open framework. At or about the surface landing there may be a head house if built of fire resistive material.

(13) Where fire is used for heating hoppers, any enclosure shall be of incombustible material.

(14) All incandescent lamps shall be so placed that they cannot come in contact with any combustible material.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

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Ind 6.08 Shaft and tunnel lighting. (1) All lighting in tunnels and shafts shall be by electricity only. While work is in progress tunnels, stairways, shafts, ladderways and all places on the surface shall be illuminated by bulbs of no less than 60 watts at intervals of no more than 25 feet. All incandescent lamps shall be enclosed in a protective basket guard.

(2) The exterior of all lamp sockets shall be entirely non-metallic with the exception that for flood lamps the supporting shell may be of metal.

(3) Lamp cord, where used for temporary lighting connections, shall have extra heavy insulation. Portable electric hand lamps, if used shall be equipped with a keyless socket of non-combustible, non-absorbent insulating material, large handle of non-absorbent insulating material and a basket guard.

(4) When wires used for light and power in tunnels and shafts are uncased, heavy type S rubber covered cable or equivalent shall be used. Cables shall be supported on insulators except when not possible to do so in tunnel headings or when used in connection with portable hand lamps.

(5) On a tunneling project, wires which are not armored shall have mechanical protection wherever exposed to injury.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.09 Electrical equipment. (1) **DEFINITIONS.**

(a) *Voltage of a circuit.* The greatest effective difference of potential between any two conductors of the circuit concerned.

(b) *Grounding.* Grounding any part of an electrical system shall consist in so connecting such part to the earth that there shall be no material difference of potential between such part and the earth.

(c) *Underground station.* The term "underground station" as used herein shall mean any place where electrical machinery is permanently installed in a tunnel.

(d) *Carrying capacity.* The term "carrying capacity" shall mean the current carrying capacity of a given wire as limited by the Wisconsin State Electrical Code.

(e) *Guarded.* The term "guarded" shall mean effectually covered, enclosed or otherwise guarded by means of suitable covers, casings, screens or barriers so as to prevent accidental contact with live parts of apparatus or circuits. Wires which are insulated, but not otherwise protected are not construed to be guarded.

(2) **SCOPE.** Except where the provisions of section Ind 6.09 apply the provisions of the Wisconsin State Electrical Code shall apply.

(3) **CARE OF EQUIPMENT AND PRACTICES.** No person shall be allowed to install or handle electric lights, or conductors, or work on or with electrically driven apparatus, unless he shall be competent and shall have been previously instructed in the performance of his duties by the tunnel superintendent, tunnel foreman, or a person authorized by either.

(4) **GROUNDING.** All non-current carrying metal parts of electrical equipment, including frames and bed plates of generators, transformers, compensators, rheostats and motors shall be permanently

and effectively grounded. All metallic fittings, coverings and armoring of cables are included. The neutral conductor of a three wire system and some point of any low voltage system (300 volts or less) shall be grounded. See Wisconsin State Electrical Code.

Note: This section requires the grounding of the non-current carrying parts of portable tools, such as drills. An additional conductor in the portable cord and a grounding contact in the plug and receptacle will provide the best means of permanent and effective grounding.

(5) SUPPORT OF CABLES AND WIRES. All underground cables and wires, unless provided with grounded metallic covering, shall be supported by insulators. The conductors connecting lamps to the power supply shall in all cases be insulated.

(6) OVERHEAD LINES ABOVEGROUND. Overhead transmission lines between the generating station or sub-station and the tunnel entrance shall be supported upon insulators which shall be adequate in quality, size and design for the voltage transmitted. Where such line is more than 500 feet in length, lightning arresters shall be installed in connection therewith. All overhead lines, except in the case of trolley wires, shall be maintained not less than 14 feet above the ground at the lowest point, except at the point of entrance to the tunnel.

Note: If wires cross areas accessible to vehicles or if the voltage exceeds 300, greater clearances shall be provided as required by the Wisconsin State Electrical Code.

(7) BRANCH CIRCUITS. Every branch circuit shall be provided with a switch of ample carrying capacity and suitable fuses on each phase within 50 feet of the point where it leaves the main circuit.

(8) POWER WIRES AND CABLES. (a) In all shafts, whose angle of inclination is more than 45 degrees from the horizontal, and in all hoisting shafts or manway compartments, all power wires and cables shall be amply protected by insulation and substantially fixed in position. All shaft cables shall be supported on insulators that cannot cause abrasion of the covering or insulation, so spaced that no part of the cable shall be under a tension greater than $\frac{1}{4}$ of its ultimate strength. The cable shall be held in position at points between the insulators by grips or cleats that cannot cause abrasion of the covering or insulation. Where the cables are not completely boxed in and protected from falling material, space shall be left between them and the side of the shaft so that they may yield and lessen a blow from falling material.

Note: Section Ind 6.09 (8) (a) shall not be construed to prevent the installations of insulated wires in metal conduit to transmit power underground.

(b) Where the cables or feed wires in tunnels cannot be kept at least 12 inches from car or locomotive, they shall be protected by guards. Any trolley wires shall be guarded if less than 6 feet above track.

(9) CABLES. ENTERING FITTINGS. (a) The exposed ends of cables where they enter the fittings of any description shall be so protected and finished off that moisture cannot enter the cables.

(b) Where unarmored cables or wires pass through metal frames or into boxes or motor castings, the holes shall be lined with insulating bushings.

(10) JOINTS IN CONDUCTORS. All joints in conductors shall be mechanically and electrically efficient. Permanent joints shall be

soldered. All joints in insulated wire shall, after the joint is complete, be reinsulated to the same extent as the remainder of the wire.

(11) JOINTS IN CABLES. Where cables are joined, suitable junction boxes shall be used or the joints shall be soldered and the insulation, armoring or lead covering replaced in as good condition as it was originally.

(12) FUSES, CIRCUIT-BREAKERS AND SWITCHES. (a) Fuses and automatic circuit-breakers shall be constructed so as to interrupt the current when a short circuit occurs or when the current through them exceeds their rated capacity. No open type or link fuses shall be used.

(b) Fuses shall be stamped or marked, or shall have a label attached, indicating the maximum current that they are intended to carry. Fuses shall be adjusted or replaced only by an authorized and competent person.

(c) The capacity of fuses used to protect feeders shall not exceed the current capacity of the feeder by more than 10%.

(d) All points at which a circuit has to be made or broken shall be provided with suitable switches, which shall be so installed that they cannot be closed by gravity.

(e) All switches, circuit-breakers and fuses shall have non-combustible bases and shall be properly enclosed.

(f) All cartridge fuses, and plug fuses larger than 15 amperes capacity, shall always be so arranged that they may be disconnected from the supply circuit by properly placed switches. An individual switch shall be installed in each branch circuit of capacity larger than 15 amperes.

(g) All manual switches, including service switches, shall have suitable enclosures of such design as to permit of operation without opening the enclosure. Enclosures shall be locked, sealed or made inaccessible by other suitable methods to other than qualified persons.

1. *Exception.* Switches or switchboards and panelboards that are properly guarded or locked or located in underground stations or other similar places not accessible to other than qualified persons are exempt from provisions of section Ind 6.09 (12) (g).

(13) MOTORS. Every motor together with its starting device shall be protected by fuses or a circuit breaking device on at least one line of direct current systems and on two phases of three-phase alternating current system and by switches arranged to cut off entirely the power from the motor. The above devices shall be installed in a convenient position near the motor and in sight of it.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.10 Sanitation. (1) One outside toilet and urinal shall be provided for every 20 men employed on each shift and protection from the weather shall be provided. For any construction project occupying a location for 60 days or more, the toilet facilities shall be of a chemical type, or a flush toilet system connected to a septic tank or a sewerage system, if no other facilities are available.

(2) Potable drinking water shall be provided for all employes. Drinking water shall be protected from contamination. Common drinking cups are prohibited.

(3) A dressing room or change house shall be provided for the purpose of drying clothing of persons employed in and about the tunnel. Not less than 4 square feet of floor area shall be available for each employe. Adequate means of heating and lighting shall be provided and a temperature of not less than 70 degrees F. shall be maintained at all times. Dressing rooms or change houses shall be cleaned daily. Lockers or hangers shall be provided for clothing. Tools, equipment or other supplies shall not be kept in change houses.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.11 Ventilation. (1) During all shifts and after blasting the atmosphere shall be tested for explosive gases and sufficient oxygen with a safety lamp. If any indication of air pollution appears, tests shall be taken to determine the amount of noxious gases. At no time when men are working in the shaft or tunnel will the gases exceed the following concentration:

Carbon monoxide to be less than -----	.01 %
Carbon dioxide to be less than -----	.50 %
Methane to be less than -----	.25 %
Hydrogen sulphide to be less than -----	.001%
Oxygen to be more than -----	19.00 %

(2) If repeated tests show an excess of these concentrations for any of the gases, mechanical ventilation shall be provided and operated which will give a minimum of 1,000 cubic feet of free air per minute in each tunnel and sufficient air in addition to dilute said gases with free air to comply with the limitations of the above table.

(3) Internal combustion engines shall be so located that the exhaust gases will not enter the shaft or the air intake of compressors. Internal combustion engines shall not be operated in any tunnel or shaft.

(4) Harmful dust concentrations shall be controlled to maintain safe air in the breathing zone.

(5) The maximum silica dust concentration in the normal breathing zone shall not exceed 15 million particles under 10 microns in longest dimensions per cubic foot of air when the quartz content of the dust is 35%. Variations in free silica content will make proportional inverse changes in this standard.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.12 Timbering requirements for shafts. (1) **SHAFT TIMBER REQUIRED.** Shafts exceeding 6 feet in depth in which men are permitted to work shall be timbered, except where located in solid rock. Shaft sections shown in figures 3 and 4 may be used in accordance with the shaft timbering requirements as follows.

(2) **SHEATHING (tight).** Under normal conditions, 2 x 6 inch hardwood shall be used. When unusually wet or unstable soil is encountered, steel sheathing shall be used.

(3) **SHAFT CUTTING.** Shaft excavation shall be cut to substantially the shaft size. Overcutting and backfilling behind the sheathing shall not be permitted.

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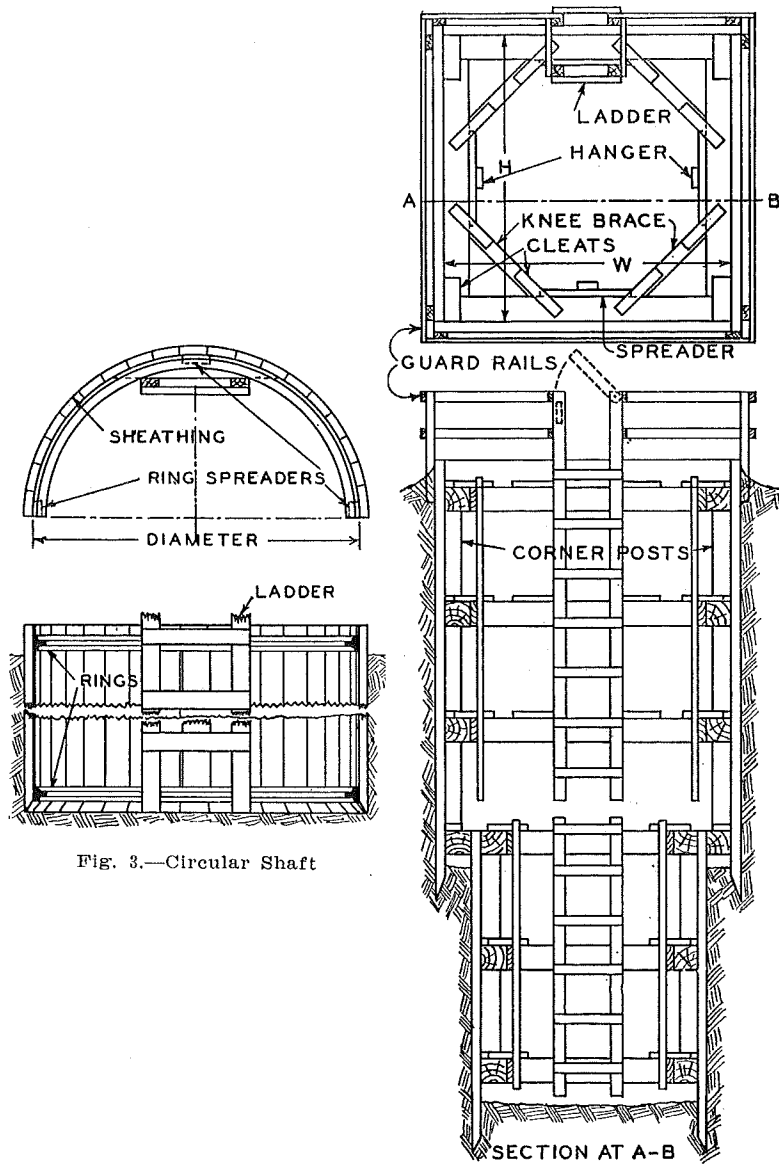


Fig. 3.—Circular Shaft

Fig. 4.—Rectangular Shaft
Timbering

TABLE 6.—BRACING OF CIRCULAR SHAFTS

Diameter	Depth	Steel Rings Required 4 feet O.C.
8' Maximum	16' Maximum	$< 2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{4}''$
10' Maximum	16' Maximum	$< 2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{5}{16}''$
12' Maximum	16' Maximum	$< 3'' \times 3'' \times \frac{1}{4}''$
8' Maximum	Over 16'	$< 2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{4}''$
10' Maximum	Over 16'	$< 3'' \times 3'' \times \frac{1}{4}''$
12' Maximum	Over 16'	$< 3'' \times 3'' \times \frac{5}{16}''$

Note 1: For depths over 16 feet, decrease ring spacing when unusually wet or unstable soil is encountered. The top ring shall be placed not more than 2 feet below ground surface.

Note 2: Other member sections may be used if it would provide equivalent section modulus.

(4) UNUSUAL CONDITIONS AND ALTERNATE DESIGNS. The requirements set forth in section Ind 6.12 are minimum. Bracing of greater strength shall be used when unusual soil conditions prevail. If shafts are constructed of greater dimensions than those set forth in the Wis. Adm. Code section Ind 6.12, drawings and design calculations for bracing shall be presented for approval to the industrial commission. Alternate designs for those set forth in this section also shall be presented to the industrial commission for approval.

(5) STAGING AND SCAFFOLDS. Staging or scaffolds shall be provided in shafts for workers when installing equipment or driving sheathing. All scaffolds shall be constructed or installed so as to support any maximum material load which may be placed on them as well as weight of the men.

(6) CLAM SHELL BUCKETS. No man shall be permitted to work in a shaft when excavation is being done with a clam shell bucket unless the longest horizontal dimension of the shaft is at least twice the length of the bucket when fully opened.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.13 Shaft protection. (1) During shaft sinking operations, the tops of all shafts shall be guarded by a suitable barricade that will keep unauthorized persons away from the opening. At night there shall be additional protection of torches or red lights. When sheathing is installed and it does not project at least 36 inches above the surface a standard guard rail with toeboards shall be provided and equipped with necessary gates. The gates shall be kept closed when not used for access to the shaft.

(2) Where cages are installed in shafts, automatic gates shall be used at the top landing. All intermediate landings shall be provided with a fence and gate or gates, the members of which shall not be more than 4 inches apart and not less than 5 feet high. The gates at such landings shall be not more than 12 inches from the openings.

TABLE 7.—BRACING OF RECTANGULAR SHAFTS

Longest Dimension of Timber Between Knee Braces or Cross Braces**	Depth	Timber or Steel Beam Required 4' O.C.	Timber or Steel Beam Required 3' O.C.	Timber Knee Braces
3' Maximum	10' Maximum	4"x6" Hardwood or 6"x6" Softwood	4"x6" Hardwood or 6"x6" Softwood	6"x6" Hardwood
4' Maximum	16' Maximum	6"x6" Hardwood or 8"x8" Softwood	6"x6" Hardwood or 8"x8" Softwood	6"x6" Hardwood
6' Maximum	14' Maximum	10"x10" Hardwood or 10"x10" Softwood	10"x10" Hardwood or 10"x10" Softwood	6"x6" Hardwood
6' Maximum	Over 14'	10"x10" Hardwood or 12"x12" Softwood or 8 WF 20*	10"x10" Hardwood or 12"x12" Softwood or 6 WF 20*	6"x6" Hardwood
8' Maximum	Any	12"x12" Hardwood or 8 WF 31*	12"x12" Hardwood or 8 WF 24*	6"x6" Hardwood
10' Maximum	Any	12 WF 36*	12 WF 27*	8"x8" Hardwood 6I 12.5 or 6C13

* WF beams shall be placed with web horizontal.

** Assuming knee braces shall lap $\frac{1}{4}$ of the span on each leg of the corner, the maximum outside dimensions of sheathing will be approximately 6', 10', 14', 18' and 23'.

Note 1: For depths over 16 feet, decrease spacing of timber or steel sets when unusually wet or unstable soil is encountered.

Note 2: For intermediate sizes of sets, members providing proportionate area and section modulus may be used.

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The gates shall be kept closed at all times except when persons or material are entering or leaving the cage.

(3) Cars shall be blocked at all landings and on the cage.

(4) Landing dogs shall be provided at all landings where cars enter or leave cage or where material is taken on or off cages.

(5) The tops of all bins or hoppers around which men are required to work shall be provided with a guardrail.

(6) Guardrail installations, if of wood construction, shall comply with the following specifications:

(a) Guardrails of not less than nominal 2x4 inch material fastened to posts and not more than 42 inches or less than 36 inches above the working level;

(b) Posts of not less than nominal 2x4 inch material, spaced not more than 8 feet apart, fastened and braced in place;

(c) Where the top of the guardrail is more than 36 inches above the working level, an intermediate rail of not less than nominal 1x6 inch material is to be placed midway between the top guardrail and the working level.

(d) Equivalent strength and stiffness is to be provided if material other than wood is used.

(7) Collars of all shafts shall be provided with efficient dams to prevent influx of water during heavy rains. Dams shall be formed by extending shaft lining not less than 10 inches above surface ground level and banking with clay or other plastic material.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.14 Ladders, stairways, and cages in shafts and caissons. (1)

All shafts where men work shall at all times be provided with ladders, stairways, or cages which shall be kept clean and in good condition.

(2) A shaft less than 10 feet in depth shall be provided with an inclined portable ladder.

(3) A shaft 10 to 30 feet in depth shall be provided with an approved ladder as described in subsection (7) and with an offset at a platform approximately 6 feet in area if the rise is over a maximum of 20 feet.

(4) A shaft 30 to 45 feet in depth shall be provided with an inclined or spiral stairway. This stairway shall be equipped with standard handrails.

(5) A shaft over 45 feet in depth shall be provided with a cage for access. This cage shall conform to section Ind 6.20. A ladder is also required as described in subsection (6).

(6) In shafts intended only as manholes, or in shafts in which the ladder is installed as an auxiliary to a cage, the minimum requirement shall be a vertical ladder without offsets, but equipped with a back rest.

(7) Every vertical ladder shall be provided with an enclosed back rest. The back rest shall have not less than 24 inches nor more than 36 inches clear distance to the ladder. The distance between centers of rungs of a ladder shall not exceed 14 inches and shall not vary more than one inch in any one ladder length. The rungs of the ladder shall in no case be less than 6 inches from the wall or any obstruction in the shaft or opening in which the ladder is used. Under no circumstances shall a ladder inclining backward from the vertical be installed. Should it be necessary to offset any section of a ladderway,

the top of the ladder section shall extend not less than 3 feet above the bottom of the section above, or hand holds shall be provided.

(8) In no case will sloping or stepping down be allowed to be used to reduce the depth of a shaft.

(9) Fixed ladders of standard construction shall be provided for access to cable sheaves on head frames located over tunnel shafts. A catwalk or platform equipped with guard rails and toeboards shall also be provided next to the cable sheaves.

(10) Ladders shall be provided at all times during shaft sinking operations.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.15 Hoists for workmen. Hoists on which workmen are permitted to ride shall be of approved design. Approval shall be obtained in advance of installation from the industrial commission.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.16 Hoisting engineer. Only experienced operators familiar with details of hoisting equipment shall be employed to operate and be responsible for such equipment. Learners shall be prohibited from operating of hoisting equipment when any person is on the cage.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.17 Hoisting rules and equipment. (1) All power driven equipment shall be maintained and adjusted in a reasonably safe mechanical condition. This includes booms, drums, clutches, brakes, sheaves and gears.

(2) When hoisting signals are used the signal code shall be posted in the engine room in sight of the hoisting engineer.

(3) The hoist shall be provided with brakes and distance marks on hoisting ropes or cables.

(4) No unauthorized persons shall be permitted in the hoist room.

(5) There shall be no conversation in the engine room while the engine is in motion or while signals are being given or received.

(6) Men shall not be hoisted or lowered into any tunnel or shaft at a speed greater than the rate posted in the engine room.

(7) After any stoppage of hoisting for repairs, the conveyance shall be run up and down the working part of the shaft at least once. The conveyance shall not be used for hoisting or lowering men during this test nor until the hoisting machinery and shaft shall have been found to be safe.

(8) There shall be no hoisting in any compartment of a shaft while under repair except as may be necessary for the repair work.

(9) The hoisting engineer shall not change shift while the bucket, skip, cage or other conveyance is in motion.

(10) The superintendent of the tunnel shall establish for each shaft rates of speed for the conveyances. Established speed shall not be exceeded in the hoisting or lowering of men. The superintendent shall post a notice of such established speed in a conspicuous place near each hoisting engine; such rates of speed shall not exceed the maximum approved by the industrial commission.

(11) The superintendent of the tunnel shall determine the maximum number of men that in his judgment may safely ride on the conveyance used in the tunnel under his supervision, and shall post in a conspicuous place near each shaft a notice stating the maximum number of persons so permitted to ride and forbidding the carrying of any greater number. The number of persons permitted to ride, as deter-

mined by the superintendent, shall not exceed the maximum approved by the industrial commission.

(12) No person shall ride upon any conveyance that is loaded with tools, timber, powder or other material, except for the purpose of handling such material while in transit and then only after a special signal has been given. When tools, timber or other material are being lowered or hoisted in a shaft, means shall be taken to prevent their shifting while the conveyance is in motion.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.18 Communications. (1) Every shaft shall be provided with an efficient means of interchanging distinct and definite communications between the top of the shaft and the lowest level and the intermediate levels from which hoisting is being done.

(2) When signals are used a code shall be printed and copies thereof shall be kept posted in a conspicuous place near entrances to work places and in such other places as may be necessary to bring them to the attention of all persons affected thereby.

(3) Some form of signalling, such as blinking lights or use of horn or intercom, shall be provided from the shaft to the tunnel face if the heading is more than 500 feet from the shaft.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.19 Hoisting ropes, hooks and sheaves. (1) Ropes or cables for hoisting or lowering men, when such hoisting or lowering is done by power hoists, shall be composed of metal wires.

(2) The factor of safety of all such ropes or cables shall be not less than five.

(3) No head or angle sheave of a diameter less than 40 times the diameter of the rope or cable shall be used for hoisting or lowering men.

1. *Exception:* This subsection does not apply to sheaves on standard equipment approved for hoisting and lowering men.

(4) Cables are considered unsafe and shall be removed when through broken wires, wear, rust, undue strain, or other deterioration the strength has decreased 25%.

(5) All ropes or cables used for hoisting or lowering men shall be thoroughly inspected once each week by some competent person designated for the purpose by the superintendent. If upon an inspection such hoisting rope, or cable shall be found to be below the requirements set forth in these rules, it shall be discontinued for such purpose forthwith.

(6) Every rope or cable used for hoisting or lowering men shall be securely fastened at both ends and when in use shall never be fully unwound; at least 2 full turns shall remain always on the drum or reel. The end of the rope attached to the conveyance in the shaft shall be bound around an oval thimble and then fastened to itself by the use of three or more clamps, or shall be securely fastened with a tapered socket.

(7) Every sheave and every idler under which is led any hoisting cable shall be provided with a guard that will keep the cable on the sheave or idler if the cable becomes slack.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.20 Cages for hoisting. (1) In all shafts or excavations over 45 feet in depth cages shall be provided for hoisting and lowering men. The cage requirement, however, does not apply to the following:

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(a) Shafts in the process of sinking. Sinking of a shaft shall include the construction of sumps or other de-watering devices, and the "turning of eyes." If but one "eye" is turned and mining started, this shall be construed as the end of shaft sinking operations. In tunnels where blasting is necessary, a mining advance of 100 lineal feet from the heading portal will be allowed. Meeting the above conditions will conclude the interpretation of a shaft in the process of sinking.

(b) Shafts being dismantled after work in tunnel is substantially completed.

(2) In all shafts under 45 feet in depth cages are not required but approved ladders or stairways shall be provided as required in Wis. Adm. Code section Ind 6.14. That portion above or below a shaft air lock structure or above a caisson shall be considered a separate shaft in determining the requirements for a stairway or a cage. However, in no case will a cage be required below a vertical lock.

(3) In any caisson or excavation regardless of depth, too small to accommodate a cage, a ladder or a stairway, men may be lowered or hoisted by a bucket or other device but only when approved by the industrial commission.

(4) Cages shall be provided with bonnets consisting of 2 steel plates not less than $\frac{1}{8}$ of an inch in thickness sloping toward each other and so arranged that they may be readily pushed upward to afford egress to persons therein, and such bonnet shall cover the top of the cage in such manner as to protect the persons on the cage from falling objects.

(5) Cages shall be entirely enclosed on two sides with solid partitions or wire mesh not less than No. 8 U. S. standard gauge, no opening in which shall exceed 2 inches.

(6) Cages shall be provided with hanging chains or similar devices for hand holds.

(7) Every cage shall be provided with an approved safety catch of sufficient strength to hold the cage with its maximum load at any point in the shaft.

(8) Cars shall be blocked while on cage.

(9) All parts of hoisting apparatus, cables, brakes, guides and fastenings shall be of the most substantial design and shall be arranged for convenient inspection. The efficiency of all safety devices shall be established by satisfactory tests before the cages are put in service and at least once every three months thereafter and a record thereof kept.

(10) The test of the safety catch shall consist of releasing the cage suddenly in such manner that the safety catches shall have an opportunity to grip the guides.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.21 Timbering requirements for tunnels. (1) Every shaft or tunnel excavation not located in solid rock in which men are permitted to work shall be kept adequately and securely timbered to prevent injury to any person from falling materials, or collapse of the sides or roof of the working place.

(2) All timbers used in the support of shafts and tunnels shall be of good quality, reasonably straight grained and free from weakening knots and other defects.

(3) All timbers shall, when placed for the support of the roof and sides of the tunnel or in the shaft, be properly fitted and wedged

in place. Timber sets in tunnels and sheathing planks in shafts shall be abutting. All void spaces in back of timbers shall be filled with blocking or other suitable material.

(4) Face boards shall be placed in all tunnel headings at end of mining shifts.

1. *Exception:* Face boards need not be placed in stable ground if mining operations are continued without interruption by the succeeding shift.

(5) Knee braces, cleats and spreaders shall be nailed in place with not less than two nails for any one piece. No nail smaller than the following shall be used for the various thicknesses of materials as follows:

1 inch (nominal)	8d common	(2½ inches x No. 10¼)
2 inch (nominal)	16d	(3½ inches x No. 8)
3 inch (nominal)	30d	(4½ inches x No. 5)
4 inch (nominal)	50d	(5½ inches x No. 3)

(6) In tunnels using timber bracing and liner plates, no excavation shall be carried more than 24 inches in advance of bracing. In tunnels using steel rings and lagging, the advance may be 4 feet in good soil.

(7) In solid stable soil tunnel sections shown in figures 5 to 10 may be used if timbered within the following limitations.

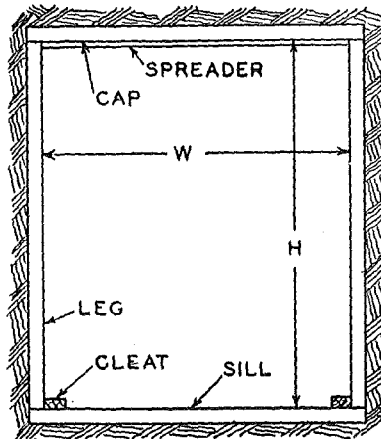


Fig. 5.—Box Type of Timbering.

Width Maximum in Feet W	Height Maximum in Feet H	Dimensions of Timbering			
		Caps, Sills Thickness in Inches	Legs Thickness in Inches	Spreaders (One in every set) Inches	Cleats Inches
3	4	2	2	1 x 4	2 x 4
4	4	3	2	1 x 4	2 x 4
5	5	3	3	1 x 4	2 x 4
5	6	3	3	1 x 4	2 x 4

Note: The use of either spreaders or cleats in Figure 5 is required. Cleats shall consist of 2 x 4 inch lumber not exceeding 3 feet in length.

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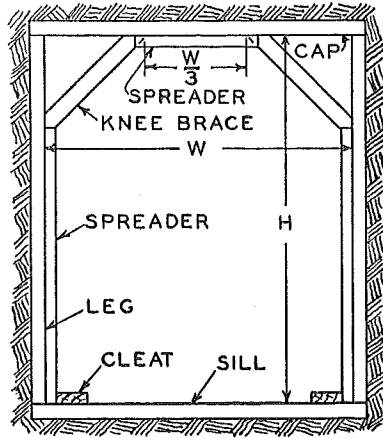


Fig. 6.—Box Type of Timbering.

Width Maximum in Feet W	Height Maximum in Feet H	Dimensions of Timbering		
		Caps, Legs, Sills, Knee Braces, Thickness in Inches	Spreaders (One to every set) Inches	Cleats Inches
8	8	3	2 x 6	2 x 6
10	10	4	2 x 6	2 x 6

Note: Knee braces shall be spaced not exceeding 2 feet center to center and may be removed immediately preceding concrete or masonry work at that point.

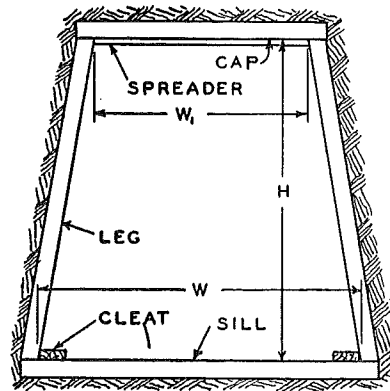


Fig. 7.—Modified Box Type of Timbering.

Width Maximum in Feet		Height Maximum in Feet H	Dimensions of Timbering		
W_1	W		Caps, Legs, Sills Thickness in Inches	Spreaders one to every set Inches	Cleats Inches
3	5	4	2	1 x 4	2 x 4
5	7	7	3	2 x 6	2 x 6
8	10	10	4	2 x 6	2 x 6

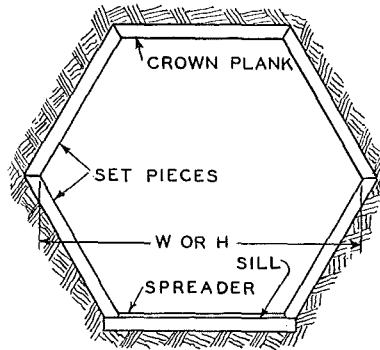


Fig. 8.—Hexagonal Type of Timbering.

Width Maximum in Feet W	Height Maximum in Feet H	Dimensions of Timbering	
		Crown Planks, Set Pieces, Sills Thickness in Inches	Spreaders (One to every set) Inches
10	10	3	2 x 6

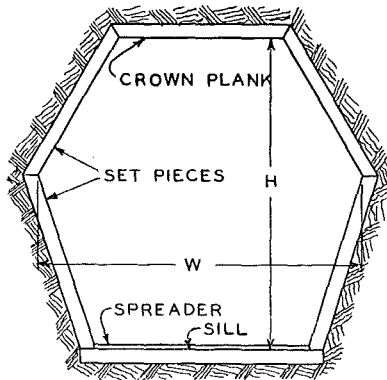


Fig. 9.—Modified Hexagonal Type of Timbering.

Width Maximum in Feet W	Height Maximum in Feet H	Dimensions of Timbering	
		Crown Planks, Set Pieces, Sills Thickness in Inches	Spreaders (One to every set) Inches
10	10	3*	2 x 6

* Use 4 inch plank if length of any piece exceeds 6 feet.

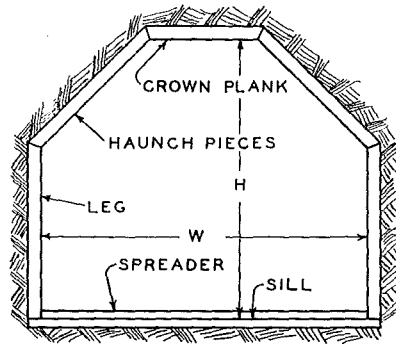


Fig. 10.—Arched 6-Piece Timber Set.

Width Maximum in Feet W	Height Maximum in Feet H	Dimensions of Timbering	
		Crown Planks, Legs, Haunch Pieces, Sills Thickness in Inches	Spreaders (One to every set) Inches
5	6	3*	2 x 6
10	10	3*	2 x 6

* Use 4 inch plank if any piece exceeds 6 feet.

(8) In excavating heavy soil which cannot be held in place with timber sections shown in Figures 5 to 10, inclusive, timber sections shown in Figures 11 and 12 shall be used with the following limitations.

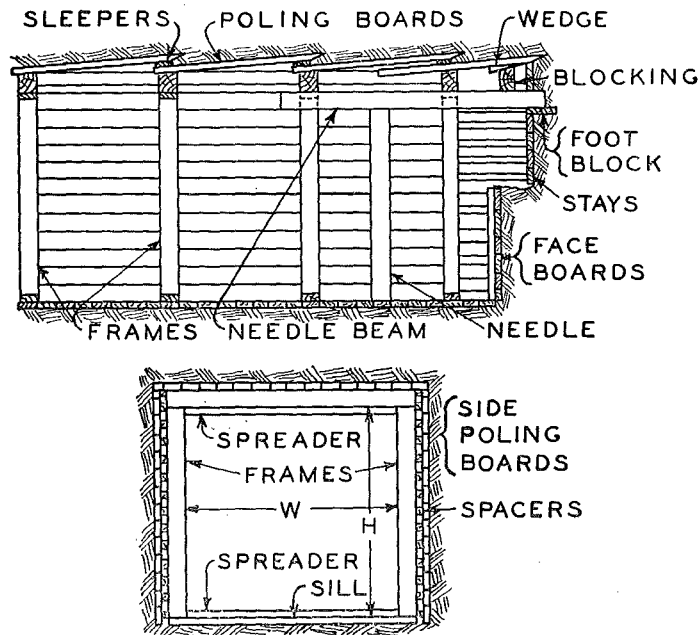


Fig. 11.—Poling Board Method of Timbering.

Width Maximum in Feet W	Height Maximum in Feet H	Sheathing Thickness in Inches	Framing Timbers	
			Dimensions in Inches	Maximum Spacing in Feet
5	5	2	6 x 6	4
7	7	2	8 x 8	4
8½	8½	2	10 x 10	4
10	10	2	10 x 10	3½

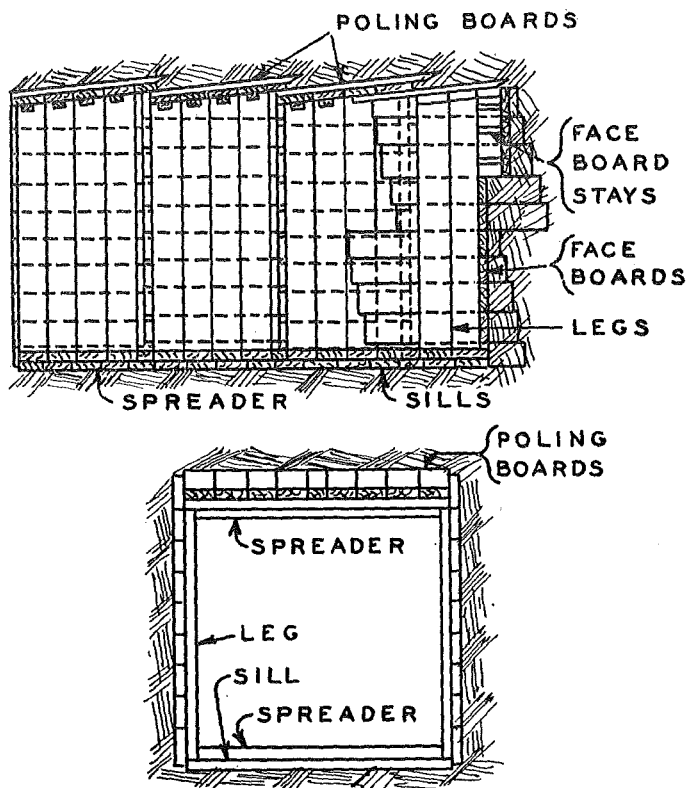


Fig. 12.—Poling Board Method of Timbering.

Width Maximum in Feet W	Height Maximum in Feet H	Sheathing Thickness in Inches	Set Pieces Thickness in Inches	Spreaders Inches	Cleats Inches	Knee Braces Inches
4	3	1	2	1 x 4	2 x 4	-----
5	6	1	3	1 x 4	2 x 4	-----
8	8	1	4	1 x 4	2 x 6	3
10	10	1	6	1 x 4	2 x 6	4

(9) For tunnels of greater dimension than indicated in figures 5 to 12, or for modifications or combination of sections of timbering for the same, drawings and design calculations shall be submitted to the industrial commission for approval. The use of metal liners is subject to the approval of the industrial commission.

(10) Tunnel excavations in which men are permitted to work shall not be less than 3 feet wide nor less than 4 feet in height. These measurements apply to distance between timbers.

(11) Any metal shield used for tunnel work shall be of a design subject to the approval of the industrial commission.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.22 Mechanical haulage. (1) When mechanical haulage is used, care shall be taken that the speed is not excessive depending upon the grades and condition of the tracks. No cars shall be pushed underground where it is practical to draw and all locomotives shall be equipped with headlights and gongs. Trolley poles shall be trailed whenever it is possible to do so. No locomotive shall be operated by a person under 18 years of age. No gas locomotive shall be used in any tunnel.

(2) Standing cars shall be blocked.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.23 Sumps. All sumps shall be securely covered or fenced except when being cleaned or repaired.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Part IV

ADDITIONAL RULES FOR WORK WHEN DONE UNDER COMPRESSED AIR

Ind 6.24 Hours of work. (1) (a) At pressures up to and including 16 pounds, an employe shall be permitted to work a total of 8 hours in one period with a 30 minute rest interval to be taken near the middle of the period. This rest interval need not be spent in open air unless it is convenient to do so.

(b) Not more than one 8-hour period shall be worked in any 24 hours.

(2) (a) At pressures over 16 pounds, an employe shall be permitted to work for limited periods in accordance with the restrictions of Table 9 and paragraphs (b) and (c) of this rule. *Attention is called specifically to the requirement that normal work periods be such that the time required for decompression falls above the dotted line in table 9.*

(b) Not more than 2 periods shall be worked in any 24 hours.

(c) The minimum time required in open air between work periods shall be as follows:

TABLE 8

Basic Pressure More Than (A) But Not More Than (B)		Minimum Time Required in Open Air Between Work Periods—Hours
(A)	(B)	
16	26	1
26	34	2
34	40	3
40	44	4
44	48	5
48	50	6

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(d) A normal work period is a period of operation regularly scheduled in accordance with the restrictions of table 9 and paragraphs (b) and (c) of this rule. *Under emergency conditions, when necessary to prevent loss of life, the project or equipment, a person may be under compression for longer than the normal work period, in which case special consideration must be given to the longer decompression time required in accordance with table 9.*

(e) The maximum pressure attained for a duration of more than 15 minutes in any work period shall be the "basic pressure" for that period.

(3) (a) Persons who have not previously worked in compressed air shall not work more than one period in the first 24 hours.

(b) No person shall be subjected to pressure in excess of 50 pounds except in an emergency.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.25 Period of compression. (1) When workmen enter the lock, air pressure shall not exceed 5 pounds during the first minute, then the pressure shall be held constant for an interval long enough to ascertain whether workmen are affected, and a similar pause shall be made after each 5 pounds raise in pressure.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.26 Decompression. (1) No person shall be permitted to pass to open air from a chamber in which work is being done under pressure except after decompression in an air lock in accordance with the provisions of Table 9 and paragraphs (2), (3) and (4) of this rule.

(2) The reduction of pressure in the minimum decompression time specified in Table 9 shall not be greater than to one-third of the basic pressure in the first 2 minutes. The reduction from this one-third pressure shall be accomplished at a rate as uniform as possible in the balance of the time required.

(3) If, at pressures over 16 pounds, the second work period is shorter than the first work period, the longer decompression time of the first period shall also be used after the second period.

(4) (a) When it is not reasonably practical to provide an approved man lock in direct connection with a working chamber, decompression may be accomplished as follows:

1. A separate decompression chamber meeting all the requirements of a man lock shall be provided at a location such that the total time spent in primary decompression in the working chamber air lock at a reasonably rapid rate, going from that air lock to the decompression chamber, and recompression in that chamber shall not exceed 5 minutes. This decompression chamber shall be in addition to the required medical lock. The medical lock shall not be used for this purpose.

2. Recompression in the decompression chamber shall be to a pressure substantially equal to the pressure of the working chamber which it is serving.

3. Final decompression in the decompression chamber shall be in accordance with the requirements of Table 9 and paragraphs (2) and (3) of this rule.

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(5) Posted conspicuously inside of and at the entrance to each man lock or decompression chamber shall be a copy of Table 9 and a schedule showing the hours for starting and ending work periods and rest intervals for each shift at the pressure then in use in the work chamber. Violations of these rules shall be noted on the record of the individual involved.

TABLE 9.—SCHEDULE OF WORK PERIODS AND DECOMPRESSION TIME FOR WORK UNDER AIR PRESSURE

Basic Pressure		Total Minimum Decompression Time—Minutes									Lowest Pressure in First 2 Min.	Minimum Time in Open Air Between Work Periods
More Than (A) to Not More Than (B) psi		Work Period—More Than (C) But Not More Than (D) Hrs.										
		More Than 4 Hours Min.	(C) = 3½	3	2½	2	1½	1	½	0		
(A)	(B)	(D) = 4	3½	3	2½	2	1½	1	½	psi	Hours	
10	12	5	3	2	2	1	1	0	0	0	4	0
12	14	8	6	4	3	2	2	1	1	0	5	0
14	16	13	10	7	5	4	3	2	2	1	5	0
16	18	18	14	11	8	6	4	3	3	2	6	1
18	20	26	18	15	12	9	7	5	4	3	7	1
20	22	32	22	19	16	13	10	8	6	4	7	1
22	24	38	26	23	20	17	14	11	8	5	8	1
24	26	48	34	30	25	21	18	14	10	6	9	1
26	28	58	44	40	33	27	24	17	13	7	9	2
28	30	67	54	30	42	34	29	22	16	9	10	2
30	32	76	63	59	52	42	34	27	18	10	11	2
32	34	85	72	67	61	51	39	31	20	12	11	2
34	36	93	80	76	70	60	45	36	23	13	12	3
36	38	100	89	84	78	69	55	41	28	15	13	3
38	40	107	97	92	86	77	64	46	33	18	13	3
40	42	115	104	100	94	85	72	51	37	20	14	4
42	44	122	111	107	101	93	79	57	41	22	15	4
44	46	129	118	114	109	101	87	65	46	24	15	5
46	48	135	125	122	117	108	95	74	50	26	16	5
48	50	141	132	128	124	116	103	82	54	28	17	6

Normal work periods shall be such that the time required for decompression falls above or to the right of the dotted lines. A work period is any period of time that a person is subjected continuously to air pressure.

(See Examples on next page)

INSTRUCTIONS AND EXAMPLES

The working pressure is selected in the first column of Table 9. By following that line to the right, the first column of figures to the right of the *dotted* line indicates, at the top, the maximum normal work period at that pressure. The figure in that column at the pressure selected is the total number of minutes required for decompression after a normal work period. Following to the right across the table to the next to the last column is the lowest pressure to which a person may drop in the first 2 minutes of decompression. From this pressure to zero will require the balance of the time. The last column to the right indicates the minimum number of hours that must be spent in open air between work periods at the pressure selected.

Example 1. If a person wishes to know the requirements at a basic pressure of 25 pounds per square inch, he finds that the normal work period must not be longer than 3 hours; for decompression he requires 25 minutes. He may drop the pressure from 25 to 9 pounds during the first 2 minutes of decompression, leaving 23 minutes to drop from 9 pounds to 0, and he must spend at least one hour in open air before working another period.

Example 2. At 35 pounds pressure, he may work 1½ hours, requires 36 minutes for decompression, may drop to 12 pounds in the first 2 minutes and use 34 minutes to drop to 0 pounds. He shall not work another period until he has spent at least 3 hours in open air.

Example 3. If a superintendent, for example, should spend only ½ hour in the working chamber at 35 pounds pressure, the total decompression time required would be 13 minutes, dropping to 12 pounds in the first 2 minutes and taking 11 minutes to drop to 0 pounds.

Example 4. If a workman at 35 pounds pressure was obliged to work an extra hour, or 2½ hours, to clean out a concrete pipe line that had jammed, he would be required to take 60 minutes for decompression, dropping to 12 pounds in the first 2 minutes and taking 58 minutes to drop to 0 pounds.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.27 Gauges. (1) A recording gauge to show the rate of decompression shall be connected to each man lock. A recording gauge shall also be placed to show the air pressures in the working chamber. The dial shall be of such size that the amount of rise or fall in the air pressure within any 5 minutes shall be readily shown.

(2) There shall be on the outer side of any working chamber at least one pressure gauge, which shall be accessible at all times and shall be kept in accurate working order. Additional fittings shall be provided so that check gauges may be attached at all necessary times. Pressure gauges shall be checked every 24 hours and a record kept of such check. One gauge shall be installed near the compressor station.

(3) Whenever men are working under a lake or stream a competent man shall be placed in charge of the valves and gauges which regulate and show the pressure in the working chamber. He shall not be employed more than 8 hours in any 24. At no time shall he operate more than 2 separate air lines.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Register, December, 1962, No. 84
Trench, Excavation and Tunnel Construction

Ind 6.28 Exhaust valves. (1) Exhaust valves shall be provided, having risers extending to the upper part of chamber, if necessary, and shall be operated at such time as may be required and especially after a blast, and men shall not be required to resume work after a blast until the gas and smoke have cleared.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.29 Communication. (1) Suitable means of communication shall be maintained at all times between the working chamber and the power house and the surface.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.30 Safety screens. (1) When a tunnel heading extends beyond the shore line, screens shall be installed, and they shall at no time be at a distance of more than 200 feet behind the face.

(2) Whenever compressed air is employed in caisson work and the working chamber is less than 12 feet in length and when such caissons are at any time suspended or hung while work is in progress so that the bottom of the excavation is more than 9 feet below the deck of the working chamber, a shield shall be erected therein for the protection of the workmen.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.31 Man locks. (1) Every caisson or shaft shall have at least 2 locks in proper working condition, one of which shall be used exclusively as a man lock. Every tunnel which will contain a finished sewer 12 feet or over in diameter shall have at least 2 locks in proper working condition, one of which shall be used exclusively as a man lock. Locks in caissons or shafts are termed vertical locks, while locks in tunnel headings are termed horizontal locks. If the horizontal lock to be installed in a tunnel heading for a sewer under 12 feet in finished diameter conforms with the requirements set up for a man lock relative to size, capacity, valving, etc., the use of one lock (combination man and muck lock) is permitted. An additional lock for use in case of emergency may be required by the industrial commission. Emergency locks shall be large enough to hold an entire heading shift. The requirements for smaller operations or unusual conditions will be considered by the industrial commission at the request of the employer and the tunnel owner.

(2) The man lock shall be large enough so that those using it are not compelled to be in a cramped position. Horizontal locks shall not be less than 5 feet in height. Vertical locks shall not be less than 7 feet in height. Man locks shall be large enough to provide 30 cubic feet per man, and shall be provided with seats for the normal capacity. Man locks shall be provided with doors that can be operated by one man from either inside or outside of the lock.

(3) All locks used for decompression shall be lighted by vapor-tight electric lamps and shall contain a pressure gauge, a timepiece, and a glass "bull's eye" in each door or in each end.

(4) Valves shall be so arranged that the man locks can be operated both from within and from without. The valves shall be of such size and type that pressure changes can be readily controlled. The locks shall be maintained in such condition that control is possible.

(5) Facilities shall be provided for heating in the man locks. Adequate ventilation shall be provided at all times. This can be accomplished by cracking the intake and outlet valves when necessary.

(6) Access ladders and platforms into, through, and out of vertical locks shall be such that no special agility is required.

(7) A voice communication system shall be provided to the inside of the man lock from the working chamber and from the outside.

(8) The following instructions for the guidance of compressed air workers shall be posted conspicuously in the change house and in man locks by the employer:

(a) Never go on shifts with an empty stomach.

(b) Avoid all alcoholic liquors.

(c) Eat moderately.

(d) Sleep at least 7 hours daily.

(e) Keep bowels regular.

(f) Take extra outer clothing into the tunnel when going on shift and wear it during decompression to avoid chilling during that period.

(g) To stimulate circulation, rub limbs freely during the decompression.

(h) Drink hot coffee and take warm shower bath and a brisk rub-down after each shift.

(i) Do not give men suffering from compressed air illness any intoxicating liquor.

(j) After you have had a cold, or if your ears are uncomfortable, or if you do not feel well for any reason, report at once to the medical facilities for a check-up. This will prevent you from developing the "bends" or from getting or contracting other illnesses.

(k) If you are taken sick away from the plant, communicate at once with the physician in charge, Dr. -----, Telephone -----.

(l) Wear your identification tag on your wrist so that it will be known what to do with you in an emergency.

(m) Stay about the job for at least $\frac{1}{2}$ hour after locking out.

(n) See that you are re-examined, as required by the rules of the industrial commission.

(o) Do not work more than two periods in any 24 hours.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.32 Compressor plants. (1) Good and sufficient air compression plants shall be provided to supply air for all conditions, including periods of repair or emergency.

(2) These plants shall be capable of furnishing to each working chamber a sufficient air supply for all pressures to enable work to be done as nearly as possible in the dry.

(3) There shall be 2 compressor plants, one for emergency use, to supply air for compressed air work. The power supplies to each plant shall be from independent sources. The plants shall be at least 10 feet apart in fire-resistive enclosures. The air intakes for the units shall be protected from the possibility of contamination, including fire or exhaust gases.

(4) Duplicate air feed pipes shall be provided for the compressor plant to a point beyond the lock whenever work is being constructed under ponds, rivers, and lakes or other bodies of water.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Register, December, 1962, No. 84
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Ind 6.33 Sinking of caissons. No caisson shall be dropped by the method of removing the air pressure therein for a greater depth than 24 inches, and then only by the person in charge at the time.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.34 Bracing of caissons. All caissons shall be properly and adequately braced before loading with concrete or other weight.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.35 Sanitation and ventilation. (1) An air chamber shall not be contaminated by any excretion or other nuisance. At least one approved chemical toilet shall be provided in the working chamber. Such facilities shall be maintained in a sanitary condition.

(2) No smoking shall be permitted in the air chamber.

(3) The supply of fresh air to the working chamber shall be sufficient at all times to permit work to be done without danger or discomfort. All air supply lines shall be equipped with check valves and carried as near to the face as practicable when used for ventilation. The air shall be analyzed as required and a record kept of the same.

(4) Care shall be taken to keep all parts of tunnel, caissons, and other working compartments, including lockers, dry rooms, rest rooms and other equipment in a sanitary condition and free from refuse, decaying, or other objectionable matter.

(5) When temperatures in underground workings exceed 95° F., effective means shall be employed to reduce such temperatures. This requirement does not apply to tunnels extending less than 50 feet from shafts.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.36 Health requirement for compressed air operations. (1) **CHANGING CLOTHES.** Men working in compressed air shall be required to change clothes at the start and termination of shifts. The change shanty as required in Wis. Adm. Code section Ind 6.10 (3) shall be located reasonably close to the shaft. Access to it shall be protected by an enclosure wherever advisable.

(2) **COFFEE AND UTENSILS.** A sufficient supply of hot coffee and sugar shall be supplied to men working in compressed air at the termination of shifts and during rest periods. Coffee shall be heated by means of other than direct steam. Coffee containers and cups shall be kept in a clean and sanitary condition at all times. All containers shall be kept covered at all times.

(3) **RESTRICTED PERSONS.** The following persons shall not be permitted under compressed air:

(a) Persons addicted to the excessive use of intoxicants or drugs.

(b) Persons suffering with general arteriosclerosis, high blood pressure, heart lesions (valvular or muscular), disturbances of blood circulation, chronic or acute respiratory diseases, or any disease of the kidneys. Every applicant for employment should submit a specimen of urine for analysis.

(c) Fat individuals, undernourished, or anemic persons.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.37 Medical attendance and regulations. (1) Any person or corporation carrying on any work in the prosecution of which men are

engaged or permitted to work in compressed air, shall engage one or more licensed physicians who shall have had experience, or shall have familiarized himself with compressed air work.

(a) No person, including authorized inspectors, shall be permitted to enter compressed air zones unless he shall have been examined and certified by a physician as being physically fit for activity in compressed air.

(b) In the event of absence from work of any employe for 5 or more successive days due to illness, he shall not be permitted to resume work until he has been re-examined by the physician and his physical condition reported to be such as to permit him to work in compressed air.

(c) After a person has been employed continuously in compressed air for a period of 3 months, he shall be re-examined by the physician and he shall not be permitted to work until such re-examination has been made and he has been reported as physically qualified to engage in compressed air work.

(d) A complete and full record of examinations made by the physician shall be maintained. A uniform examination blank, prescribed or furnished by the industrial commission, shall be used by each medical examiner, and the record of such examinations shall be available to the industrial commission. A list of the employes with the dates of their physical examinations shall be available at the location where the work is in progress.

(e) In cities and communities in which no hospital or health institution maintains a medical lock, such a lock shall be established in connection with all work in compressed air when the maximum pressure exceeds 17 pounds. Medical air locks, if cylindrical, shall be not less than 5 feet in diameter, and if rectangular, shall be not less than 5 feet in width and 5 feet in height. The lock shall consist of two compartments, each compartment long enough to accommodate a cot or bench 6 feet long with sufficient clearance to permit opening and closing of doors. Each door shall be provided with a glass "bull's eye". Each compartment shall be fitted with air valves so arranged to be operated from within and without and shall be kept properly heated, lighted and ventilated and shall contain a caisson gauge, a two-way speaker system connected to the outside and buckets of sand and water for fire fighting. Construction of benches, flooring and other fittings shall be of metal or fire-resistive material. Paint shall be of the fire-retarding type and kept to a minimum. The chamber shall be kept clean and free from all oily deposits and volatile materials of any kind. Clothing and bedding material shall be free of grease or oil. Bedding material shall be flame resistant. No flame, matches, cigarette lighter, lighted cigarette, cigar, or pipe shall be carried into the chamber at any time. All electrical wiring shall be of a heavy duty type in conduit. All electrical switches shall be located outside the chamber. If oxygen breathing equipment is used, it shall be maintained in perfect condition and shall be used only under the direct personal supervision of an employe trained in the use of oxygen. The source of oxygen supply shall be located outside the chamber. No electrical appliance (i.e. fan) shall be used in the chamber during oxygen breathing nor afterward until the chamber has been well ventilated. During the use of oxygen extra ventilation shall be provided in the chamber.

(f) A wrist identification tag with band shall be furnished by the employer to all employes advising police officials that the employe is a compressed air worker; stating location of medical lock, and stating that in case of emergency an ambulance surgeon shall remove the patient to the medical lock and not to the hospital.

(g) All cases of compressed air illness shall be reported by the employer to the industrial commission as required by the Workmen's Compensation Act on a uniform blank furnished by the commission and copies of such reports shall be kept on file at the plant where the work is in progress.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 6.38 Forms. The following forms are listed in accordance with section 227.013, Wis. Stats. The forms are issued by the division of Industrial Safety and Buildings, and may be obtained from the Industrial Commission, 1 West Wilson Street, Madison 2, Wisconsin:

Form SB-42 Report of caisson disease.

Form SB-43 Physician's Report of Physical Fitness for Workers Under Compressed Air.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63.